these lines have a slight inclination from the horizontal, the northern ends being a little lower than the southern ends. The lines vary in size from a quarter of a degree in width and several degrees in length up to 1° by 10° or even larger. Near the horizon the size is always small, growing larger at the higher elevations. The conspicousness is very different on different nights and the view is always improved by good field glasses. A number of observations have been made on the motion of this detail, which in every case has been in a southerly or southwesterly direction, and a very rough analysis of the rate has given something in the neighborhood of 60 miles per hour. This structural effect, of course, exists in what otherwise appears to be an absolutely clear sky. It rises about 25° high in the west and may be traced through an azimuth of 60° or 75°. The passing of the colored sunlight across this structural detail, lower and lower towards the western mountains, was one of the first phenomena noted last September.

Five minutes after sunset the blue arch of earth shadow [(*a*) Dark segment] begins to rise above the eastern horizon with a brilliant pink curve [(*a*) First anti-twilight arch] of sunlit atmosphere immediately above it. If the night is favorable the pink arch is cut up into a large number of alternating blue and pink rays [see Abbe's translation of Heim's description, this issue of the REVIEW, p. 625] all pointing toward the spot opposite the sun. Twenty-three blue shadow rays have been counted at one time. Some of them may come from clouds visible above the western horizon and the blue shadow may be traced completely across the sky from western cloud to eastern arch. Often the shadow comes from clouds below the western horizon; but at this early moment in the evening, it can not usually be traced nearer the western horizon than 30°.

As the pink arch in the east [(*a*) First anti-twilight arch] rises higher and higher above the horizon, reaching an elevation of 8°, or 10°, or even 12° before it becomes too faint (on one occasion it seemed to appear at 18° elevation), the eastern [anticrepuscular] rays extend more and more toward the west, becoming fainter and fainter and very rarely showing directly overhead. As the pink arch in the east really disappears, 20 to 25 minutes after sunset, a pink glow begins to form in a great area extending from 10° or 15° up to 60° above the western horizon [(*d*) First purple light]. On perfectly clear nights this glow gradually settles toward the horizon [(*c*) First twilight arch] retaining for a long time between it and the horizon a deep lemon-yellow color [(*c*) First bright segment]. About 30 minutes after sunset the lemon-yellow has set [End of civil twilight] and for the next 10, 15, or even 20 minutes the pink glow is gradually disappearing below the western mountains.

When there are a few cirrus clouds at the proper distance to the west of us to cause shadows, the disappearance of the pink arch in the east [(*a*) First anti-twilight arch] with its [anticrepuscular] rays is immediately followed or even accompanied by the formation of a splendid series of bright [crepuscular] rays on the western sky. These are much brighter than those in the east and at first reach an elevation of 40° or more over the place of sunset and a length of 60° or 80°, if low, along the northwestern or southwestern horizon. The base of these rays at first may be 5° or 10° above the horizon, but as the half hour after sunset passes the rays extend from the visible horizon in a deep red color up to 10° or even 20° in altitude. As many as 22 of these bright rays, separated by as many blue shadows, have been counted at one time. A few of the very numerous measurements of elevation have been roughly worked out to get the elevation of the layer or curtain on which these rays and shadows are projected. The process is simple, for the length of time after sunset gives a rough idea of the hundreds of miles of distance between the observer and the clouds which are casting the shadows. This distance is easily shown to be 200 to 400 miles, for some of the best raylike shadows appear 30 minutes after sunset, at which moment the sun is setting at a point some 400 miles west of us. By carrying out this calculation it is easy to show that we are seeing shadows cast upon a layer about 12 miles above the surface of the earth.

As a rule, these shadows appear raylike in form, with the rays diverging from the sun (below the horizon). But occasionally rounded or elongated blue cloud shadows are observed, with direct sunlight, very deep red in color, which has passed underneath the cloud itself, and is projected higher in the western sky than the light which passes over the cloud. The color of these cloud shadows is usually blue but occasionally is a very striking green. [See Abbe's translation of Bezold, p. 622.]

When the pink afterglow [(*d*) First purple light] has sunk low in the west a faint pink glow suffuses the entire horizon [(*e*) Second anti-twilight]. As this second afterglow leaves the east it may be seen as a faint pink glow [(*g*) Second purple light] in the western sky at about an hour after sunset.

The most exquisitely beautiful combination of colors is obtained when there seems to be a long horizontal cloud shadow [(*c*) First twilight arch], cutting through [above] the western afterglow [(*c*) First bright segment] at about 25 minutes after sunset. Under such conditions the lemon-yellow area [(*c*) First bright segment] extends from the horizon perhaps 8° in height through a great part of the western sky, then comes a nearly complete interruption of shadow [(*c*) First twilight arch] above which is the most superb display of a brilliant red band [(*d*) First purple light] extending upwards perhaps 10° or more and divided into glowing [crepuscular] rays all pointing toward the sun, long since out of sight. The color of this pure red glow [(*d*) First purple light] is almost monochromatic and seems much like the color of prominences observed through the C line of hydrogen. It is so different in the splendor of its beauty from the pink edging to the afterglow seen on clear nights that it has become evident that special conditions are required to produce it at its best. And when seen at its best it forms one of the most remarkable meteorological displays ever witnessed by the writer.

TWILIGHT COLORS AT MOUNT WILSON, CAL., AUGUST-SEPTEMBER, 1916.

By WENDELL P. HOGE, Assistant Astronomer.

[Dated: Mount Wilson Solar Observatory, Cal., Nov. 1, 1916.]

[Mr. Ford A. Carpenter, Meteorologist, Weather Bureau, Los Angeles, Cal., transmits the following description of twilight colors observed at the Mount Wilson observatory, contributed by Mr. W. P. Hoge.]

In reference to red sunsets my "log book" contains the following note under date of August 4, 1916: "Very brilliant sunsets for several evenings." This indicates that these brilliant displays began about August 1. Their onset was rather sudden and they have slowly diminished in brightness, although they were quite marked during all of August. The effect is still very noticeable [November 1], particularly in the morning [when] I have a good sky line from 25 to 100 miles distant. The display is gradually growing fainter.

At early dawn a band of crimson [(*f*) Second bright segment], extending some 4° or 5° up from the horizon, appears rather suddenly. This band widens a little and changes rapidly to a deep orange, with decided yellowish green higher up. On several occasions green and orange streamers [crepuscular rays] were sent up, much resembling the aurora as I have seen it *pictured*. It then changes to a lighter yellow; and a little later a very delicate pink, shading into violet [(*d*) First purple light] comes in above it at an altitude of about 25° or 30°. The changes are all very rapid, and frequently it is a very beautiful sight. Earlier, when at its maximum brilliancy, there were indications of streaks of velvety clouds that gave one the impression of a canopy of color spread overhead far to the east, although the sky directly overhead appeared to be entirely free from clouds [Compare Douglass' "soft etching," p. 625].

Whatever the cause of these phenomena it gave us here at Mount Wilson the most wonderfully brilliant sunset and sunrise effects I have ever witnessed.

SOLAR HALO OF SEPTEMBER 28, 1916, AT MIAMI, FLA.

By RICHARD W. GRAY, Meteorologist.

[Dated: Weather Bureau office, Miami, Fla., Oct. 5, 1916.]

A solar halo that developed several progressive and interesting phases was observed at Miami, Fla., on the morning of September 28, 1916. The most important of these phases is shown in the accompanying drawing, which is reproduced from the original sketches made at the time of observation. As no instruments were available for making accurate measurements, the solar distances given and the sun's altitude are estimates, and are, therefore, liable to error. Errors in the estimates of

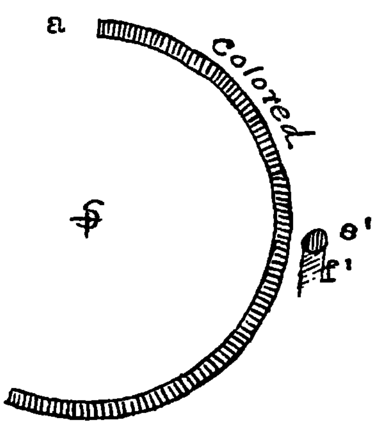

FIG. 1. Solar halo fragment seen at Miami, Fla., Sept. 28, 1916, 7:44 a. m., 90th M. time. *a*, arc of the 22°-halo; *e'*, parhelion of 22°; *f'*, Lowitz' arc(?).

the sun's altitude, however, can be corrected by computing the true altitudes from the time given and the latitude of Miami.

The phenomenon was first seen at 6:46 a. m., 90th meridian time, and at that time about 180° of the upper part of the halo of 22° was visible. To the left of the halo, and slightly above the altitude of the sun, there was a brightly colored arc, probably 5° in length, which strongly impressed the writer as being convex to the sun. The position of this arc relative to the halo and its solar distance (estimated between 35° and 40°) would seem to indicate, however, that the apparent convexity was an illusion and that the colored band was in reality a small segment of the tangent arc of the halo of 22°. The altitude of the sun at this phase of the halo was estimated at 18°.

At 7:07 a. m. the small arc to the left of the halo had disappeared and two parhelia had developed on the circumference of the halo. A rather poorly defined band of white light extended several degrees outward from the parhelion on the right of the sun, this undoubtedly being a fragment of the parhelic circle. The altitude of the sun at this time was probably 20°.

As the sun's altitude increased, the parhelia gradually separated from the halo's circumference, and by 7:40 a. m. they were well without the circle. At 7:44 a. m. (fig. 1) only the parhelion to the right of the sun was visible, and this parhelion had taken on an elongated form of 3° or 4° in extent. Both the parhelion and the band extending downward from it were brightly colored. The phenomenon was closely watched to see whether the band could be identified as a Lowitz arc, but it failed to show any appreciable curvature. This phase continued for about 20 minutes, the sun's altitude at the time being about 26°, The parhelia were visible at intervals to about 8:15 a. m.. and fragments of the halo were seen as late as 9:05 a. m.

METRIC SYSTEM FOR AERONAUTICS.

At the regular monthly meeting of the executive committee of the National Advisory Committee for Aeronautics, held December 7, 1916, the executive committee adopted the metric system as its standard so far as the committee is concerned, and recommendations will be sent to the various departments of the Government that this system be adopted in connection with all matters pertaining to aeronautics.

It is announced that the War Department will put this change into effect immediately in its Aviation Section, using both the metric and the English systems on all drawings for a time.

It is of interest to note in this connection that the upper-air meteorological observations carried on by the Weather Bureau, employed the metric system of units for all its work as early as 1908. The results secured in 1898 were published in English units, those for 1908 onward were published in metric units, beginning with the first issue of the Bulletin of the Mount Weather Observatory for August, 1908. The latest of the bureau's publications in this field, Supplements numbers 3 and 5 to the MONTHLY WEATHER REVIEW, adhere to this practice.

MEASUREMENT OF HORIZONTAL AND VERTICAL MOVEMENT IN THE ATMOSPHERE.[1]

By M. TENANI.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 28, 1916, §989.]

A small captive balloon is employed. The curve of the cord is assumed to be a catenary. The problem then is—Given (1) the weight of the cord per unit of length, (2) the tension at the lower end of the cord (measured by a dynamometer), and (3) the angle made with the horizontal by the lower end of the cord, find (*a*) the tension at the upper end of the cord and (*b*) its direction. These, with the known ascensional force of the balloon, enable the required air-current data to be computed.—*A.* [*Daniell*].

[1] Nuovo cimento, Jan.-Feb., 1916, 11:87-94.

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